Australian Government
Department of Defence
Defence Science and
Technology Organisation

Torsionmeter Removal and Reinstallation Procedure

Michael Brincat, Peter Vincent and Mark Ciacic

Maritime Division
Defence Science and Technology Organisation

DSTO-TN-1238

ABSTRACT

As part of its research program DSTO has fitted torsionmeter systems to two Armidale Class Patrol Boats, HMAS Maryborough and HMAS Glenelg. These systems consist of shaft mounted torsionmeters, an engine room mounted controller and a bridge mounted remote display. The torsionmeters are located on the bobbins which are the couplings between the propulsion system gear boxes and propellor shafts. The torsionmeters measure the torque and speed of rotation of the bobbin and consist of a rotating component (rotor) and a hull mounted surrounding component (stator). During major service of the propulsion system it becomes necessary to remove the bobbin hence the stator component of the torsionmeter must be first removed and the rotor component suitably protected. This technical note describes the process of removing the stator, protecting the rotor and reinstalling the stator.

Published by

Maritime Division
DSTO Defence Science and Technology Organisation
506 Lorimer St
Fishermans Bend, Victoria 3207 Australia

Telephone: 1300 333 362
Fax: (03) 9626 7999

AR-015-792
October 2013

APPROVED FOR PUBLIC RELEASE

Armidale Class Patrol Boat
Torsionmeter Removal and Reinstallation Procedure

Executive Summary

As part of its research program the Defence Science and Technology Organisation (DSTO) has fitted torsionmeter systems to two Armidale Class Patrol Boats, HMAS MARYBOROUGH and HMAS GLENELG. These systems consist of shaft mounted torsionmeters, an engine room mounted controller and a bridge mounted remote display. Since installation maintenance of these systems has been undertaken by DSTO staff. While the system has proved to be reliable it is attached to the vessel's propulsion system and must be removed and reinstalled during major propulsion system maintenance. The removal and reinstallation of the torsionmeters has proved to be an expensive undertaking since the only DSTO staff with the experience to perform the task are located in Melbourne, while the vessels are located in Darwin or Cairns.

This technical note describes in detail the process to remove and reinstall the torsionmeters and details the procedure for installing protective covers on the rotor component of the torsionmeters.

This report will allow Royal Australian Navy, DMS Maritime and DSTO staff with suitable trade skills to perform the work that was previously performed by DSTO Melbourne staff. It is anticipated that using a technician that is local to where the vessels are located will be considerably cheaper than the present system of flying DSTO Melbourne staff to perform the activity.

This page is intentionally blank

Contents

This page is intentionally blank

1. Introduction

The Defence Science and Technology Organisation (DSTO) have installed dual propeller shaft torsionmeters onto two Armidale Class Patrol Boats (ACPB), HMAS GLENELG and HMAS MARYBOROUGH. The torsionmeters measure shaft speed, torque and power [1]. A monitoring network controller logs the torsion meter data, along with a variety of other sensory data such as strain, acceleration, ship motions and GPS position. This data is post analysed by DSTO for use in research into structural integrity and fuel efficiency [2].

The torsion meters are commercial off the shelf Type 420 Marine Torsionmeter, supplied by DATUM Electronics, and have been used extensively throughout the Royal Navy's fleet [3]. The system consists of a torsionmeter controller shown in Figure 1, two torsionmeters (port & starboard) and a remote display shown in Figure 2. The torsionmeter units consist of a stator and rotor. The controller receives data from the torsionmeters and displays the shaft speed, torque and calculated engine power of each unit.

The purpose of this report is to outline the approved procedure to safely remove and reinstall the torsionmeter stator and protect the torsionmeter rotor during maintenance activities by ship personnel or DMS Maritime contractors. This report covers the mechanical aspects of the removal and reinstallation, it does not cover administrative or safety issues related to the removal and reinstallation. The technician performing the activity should conduct his/her own risk assessment and comply with all procedures that are in force at the time of the activity. It is important that the technician liaise with the Royal Australian Navy (RAN) and the boat maintainer prior to and during the activity.

Figure 1 – Torsionmeter control unit, mounted in engine room on HMAS GLENELG.

Figure 2 – Torsionmeter remote display unit, mounted in bridge on HMAS GLENELG

2. Overview

The torsionmeter is located on the bobbin which resides between the gearbox and the disk brake in Figure 3. The torsionmeter comprises a rotor, affixed to the bobbin shrouded by a stator, which is bolted to a mounting plate; an explode view of this is shown in Figure 4 and components are referenced in Table 1.

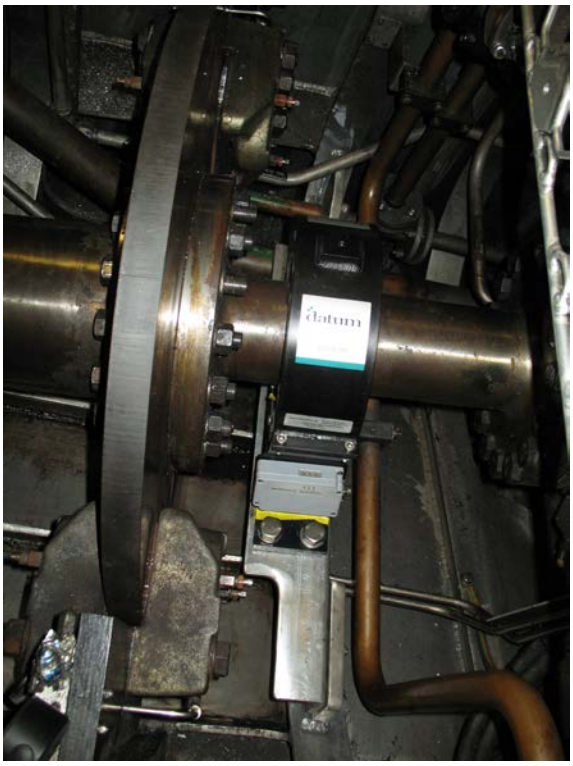

Figure 3 - Torsionmeter installed on the starboard bobbin on HMAS GLENELG

Table 1 - List of torsionmeter and associated components

Component Number	Description	Quantity
1	Bobbin	1
2	Torsionmeter stator base	1
3	Torsionmeter stator shell	1
4	Torsionmeter mounting plate	1
5	Stator mounting fasteners, comprising of a M20 x 45mm bolt, a 20mm washer and a M20 Nylock nut.	4 sets
6	Packing spacers of various sizes to align stator with rotor during installation.	Varies
7	Torsionmeter rotor.	1
8	Stator side covers	4
9	Stator shell bolt insulators (Not present in all torsionmeter installations	4
10	Stator shell fasteners, comprising of a M8 x 30mm bolts, 2 washers and a Nylock nut.	4
11	Stator side cover screws (M8 x 15mm)	16
12	Rubber stator insulation	2
13	Electrical connector	1

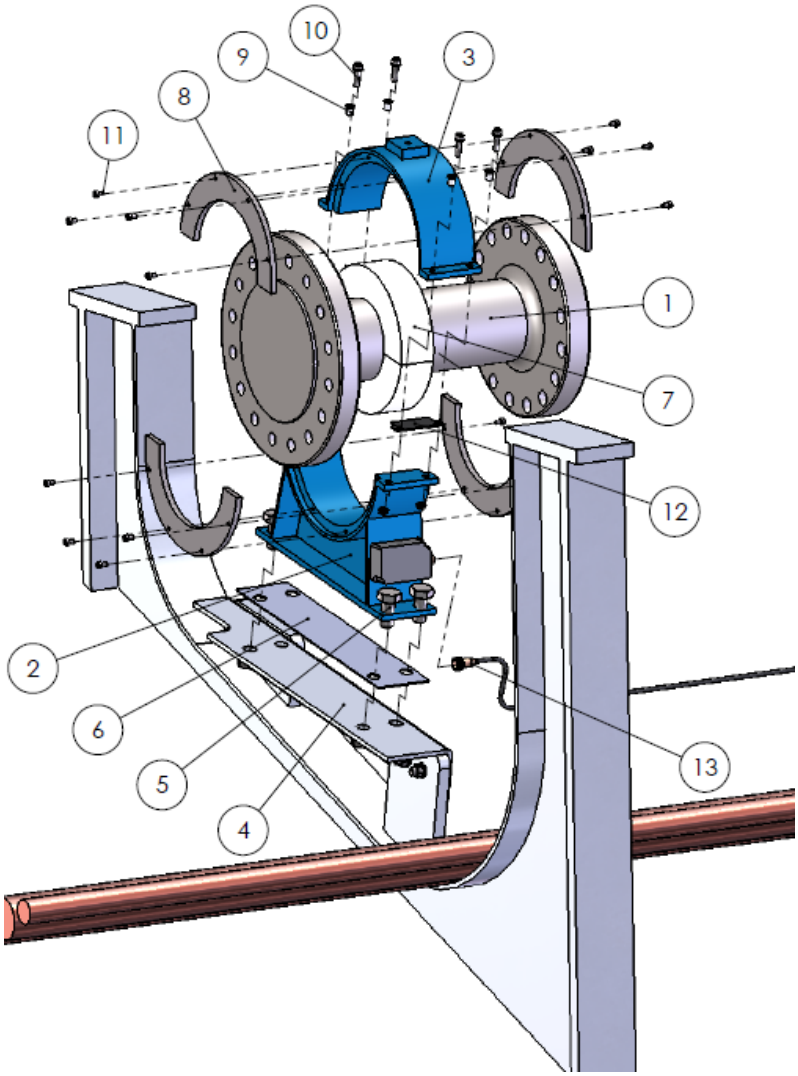

Figure 4 - Exploded diagram of torsionmeter installation. Mounting plate arrangement and torsionmeter stator/rotor covers may vary between vessels. Refer to Table 1 for description of components.

3. Preparation

Prior to commencing work on the torsionmeter approval should be obtained from both the RAN and DMS Maritime. The removal of each torsionmeter should take no more than 2 hours. It is mandatory that the engines are locked out for the required duration and the crew should be made aware that the vessel is not available during this time. DSTO Risk Assessments 2660 and 2661 should be consulted for guidance on the risks associated with this activity and are shown in Appendix C and D respectively. These are provided for guidance and the technician conducting the removal/installation should do their own risk assessment.

The torsionmeter controller is 240V AC powered. It subsequently produces an extra low voltage (12V DC) that is feed to the shaft mounted torsionmeters. In accordance with

AS/NZS3000:2007 Electrical Installations [4] section 7.5.5 Note 1, it is permissible to conduct work on the torsionmeter stators without isolation, provided that the area is dry and indoors.

It should be noted that the torsionmeter stators are 'hot pluggable' and consequently no damage will occur to the torsionmeter system if disconnection/reconnection occurs while the 12V DC is present.

The technician should familiarise themselves with all the component names, the removal/reinstallation procedure and confirm that they have all necessary equipment, as outline in Appendix A, to conduct the work. Once commencement of torsionmeter removal/reinstallation occurs the vessel will not be available for use by the crew until the work has been completed.

4. Removal Procedure

4.1 Stator Removal

- To access the torsionmeter, remove the disc brake cover plate aft of the gearbox. Then lift the prop shaft deck plate out.
- Disconnect the electrical connector, item 13 Figure 4 and cover the end with electrical tape to protect from damage and contamination.
- Tape or cable tie the electrical connector to any upright cables, to protect it.
- Using a 13mm spanner and 6mm Allen key remove the 4 stator shell fasteners.
- Remove the insulation inserts from the stator bolt holes (if applicable).
- Remove the stator shell, being careful not to lose the rubber stator insulation between the stator shell and the base, as shown in Figure 5.

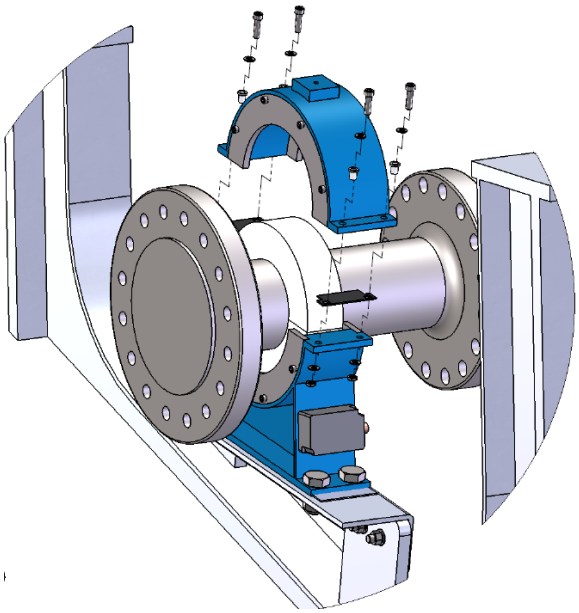

Figure 5 - Removal of stator shell.

- Using a 5mm Allen key, remove the 4 socket head screws holding the aft lower stator cover in position and remove the cover, as shown in Figure 6.

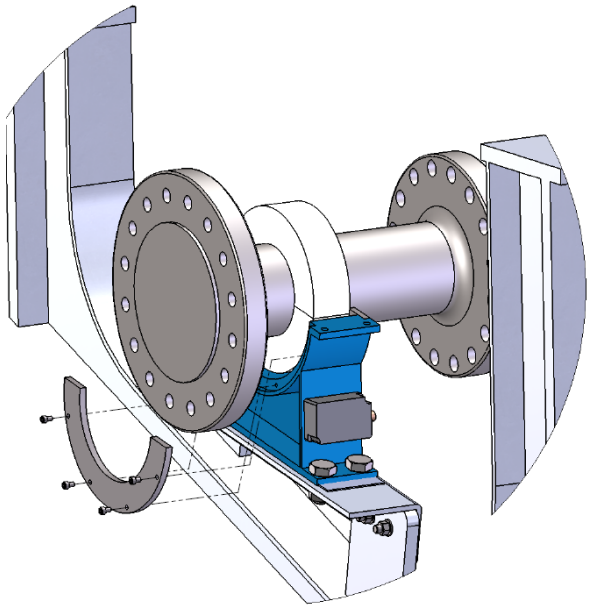

Figure 6 - Removal of stator side cover

- Using two shortened 30mm spanners, remove the four M20 stator fasteners, as shown in Figure 7. These fasteners may be tight and it can be necessary to use the spanner extender or using a soft faced hammer apply some sharp blows to the ring spanner to initially loosen the bolt.

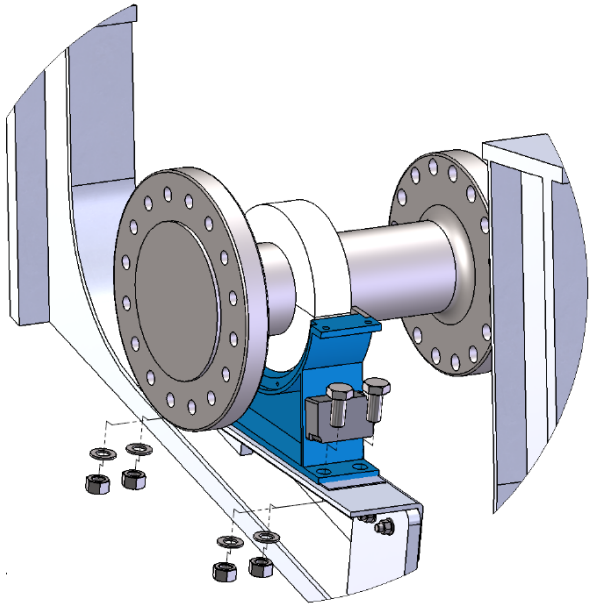

Figure 7 - Removal of stator mounting fasteners.

IMPORTANT
Take note of the orientation and quantity of the packing spacers between the stator base and mounting plate. Note: Some spacers may be tapered.

- Remove packing spacers.
- To remove stator base, slide forward and lift out, as shown in Figure 8.

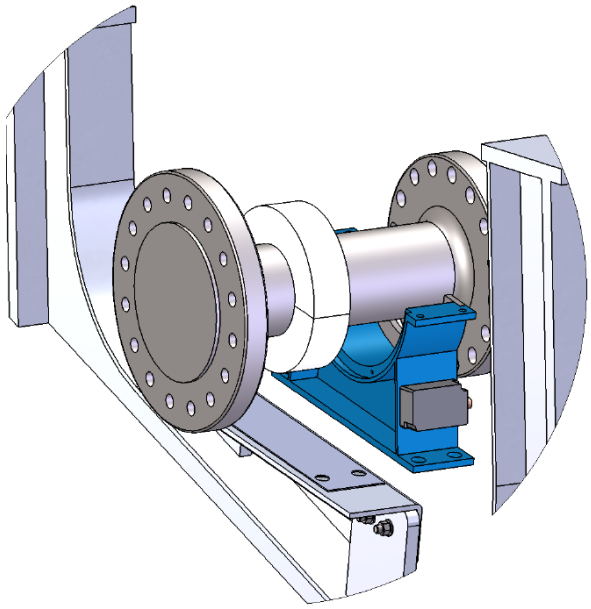

Figure 8 - Removal of stator base.

- Screw the side cover back on to stator; reassemble the stator shell and base, with all bolts, washers, insulation inserts and nuts.
- Use the M20 bolts, washers and nuts to secure the packing spacer(s) in the correct orientation to the bottom of the stator.
- Pack stator and associated tooling into pelican case, ready for transport/storage.

4.2 Rotor Guard Installation

- Disassemble yellow rotor guard into two halves.
- Place bottom half over bottom section of the rotor, keeping an even gap on each side.
- Align top rotor guard; insert and hand tighten the bolts and nuts, as shown in Figure 9.

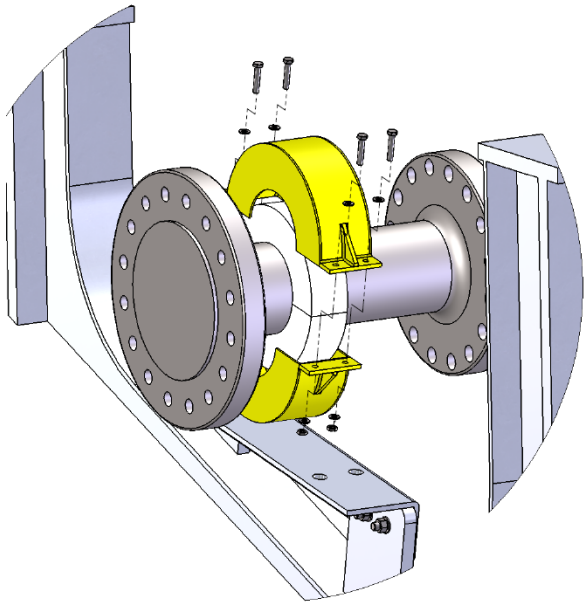

Figure 9 - Installation of rotor guard.

- Using an adjustable spanner and a 13mm spanner tighten the fasteners to secure the guard, whilst maintaining an even gap between the upper and lower guards, as shown in Figure 10.

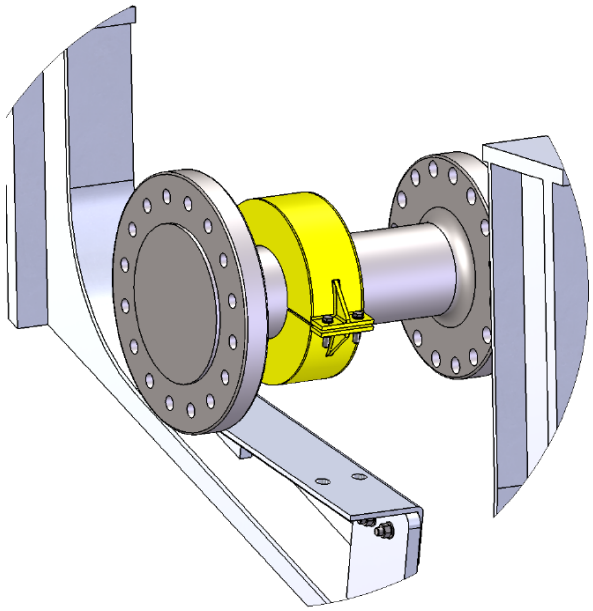

Figure 10 – Rotor guard once installed.

IMPORTANT
The rotor guard is not certified for use during engine operation. The intended purpose of the guard is to protect the plastic rotor during maintenance activities.

5. Reinstallation Procedure

The reinstallation of the torsionmeter stator is in the reverse order to the removal procedure, taking note of the following:

- Although similar in dimension, stator bases and shells are manufactured as matched pairs and it is important to keep each stator base and shell as a matched pair. In some instances the shell may only fit in one orientation on its matched base.
- Due to the above, it is also important to replace each torsionmeter into the location it was removed from, i.e. Port or Starboard. In most cases labels will be present on the torsionmeters to indicate its location and orientation to the vessel.
- The stator must be perpendicular to the bobbin.
- The stator must be concentrically aligned with the bobbin and torsionmeter rotor. This can be achieved by using a 5mm Allen key as a guide for the gap size between the stator and rotor, or any other method which adequately positions the stator.
- During maintenance the alignment of the bobbin to the torsionmeter mounting plate may have changed and therefore it may be necessary to use a different selection of packing spacers.
- It is a useful technique to have 4 x M20 normal nuts to use during the alignment stage of the reinstallation, as this reduces the time and effort required to release the fasteners if alignment is incorrect when tightened. These nuts MUST be replaced with M20 Nylock nuts once the alignment is correct.
- It is important to maintain electrical isolation between the stator base and the stator shell, as lack of isolation will cause the unit to malfunction due to improper coupling.
- Once the stator has been reassembled and correctly aligned with the rotor, the connector can be plugged back in and the unit powered. There are 3 LEDs located on the stator base which indicate the status of the torsionmeter, as shown in Figure 11.
    - Correct operation of the torsionmeter is indicated by LED3 (Green) flashing at a rate of approximately 4 times per second, indicating ‘good’ data is being received by the stator from the rotor.
    - LED2 (Yellow) illuminates when ‘bad’ data is received and remains on until ‘good’ data is received. This should not occur if correctly aligned.
    - LED1 (RED) flashes when no data (‘good’ or ‘bad’) is received. This may be due to a number of factors, e.g. cable or rotor damage, stator may be damaged or an electrical short may be present between the stator base and shell. Check that the stator shell bolt insulators and rubber stator insulation are installed correctly.

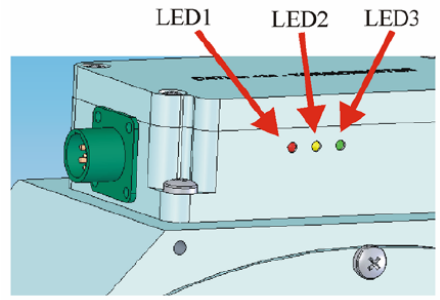

Figure 11 – Location of torsionmeter status LEDs

6. Conclusion

This report details the procedure for the safe removal and reinstallation of the torsionmeter stator by ship personnel or DMS Maritime contractors on Armidale Class Patrol Boats fitted with a DATUM Electronic Type 420 Marine Torsionmeter. This report does not cover the removal and installation of the torsionmeter rotor (only the installation of protective rotor guards) as that is a specialist task involving the application of strain gauges.

7. References

1. Fletcher, L., Scardino, A., Vincent, P. and Wilson, A. (2009) *Implications for performance and fuel consumption caused by biofouling on ACPBs*. DSTO-TN-0925, Melbourne, Vic., Defence Science and Technology Organisation (Australia).
2. Scardino, A., Vincent, P., Kennett, S. Wilson, A. and Fletcher, L. (2013) *Progress report: Armidale Class Patrol Boat underwater hull and propeller trials*. DSTO-TR-2891, Melbourne, Vic., Defence Science and Technology Organisation (Australia).
3. Ministry of Defence, Hull Fouling Working Group. (2007) *Surface Ship Hull Fouling Management*. Issue 1. Maritime Acquisition Publication Number 01.026, Bristol, MoD Abbey Wood.
4. AS/NZS3000:2007 Electrical Installations electrical work.

Appendix A: Equipment List

A.1. Required Tools

To remove and reinstall the torsionmeters you will require the following tools:

- 1 x13mm Spanner AF
- 1 x 5mm Allen Key AF
- 1 x 6mm Allen Key AF
- 1 x 30mm AF shorten ring spanner
- 1 x 30mm AF shorten open ended spanner
- Spanner extender
- ½ inch ratchet
- ½ inch extension
- ½ inch 30mm AF shallow throated socket
- No. 1 Phillips head screw driver
- 2 x adjustable 150mm spanners
- 4 x M20 normal nuts (required for reinstallation only)
- Cable ties – minimum 150mm in length
- Electrical tape
- Stator packing spacers of various thickness (required for reinstallation only)
- Soft faced heavy hammer
- Heavy gloves

A.2. Optional Accessories

To make the removal and reinstallation easier, it is recommended that the following accessories are also available:

- Pelican case with suitable packing/restraints – for transport and storage of stators/rotor guards.
- Torch
- Helmet light
- Claw grabber (to retrieve dropped items)
- Rags
- Extension mirror
- Nitrile gloves
- 150mm ruler (required for reinstallation only).

Appendix B: Contact List

If problems arise during the removal or reinstallation of a torsionmeter, guidance can be sought from any of the following contacts:

B.1. DSTO Contacts

- Peter Vincent
  Sensor Systems Specialist
  Platform Sensor Systems
  Ph. 03 9626 7505
  Email. Peter.Vincent@dsto.defence.gov.au

- Mark Ciacic
  Technical Officer
  Environmental Research & Biotechnology Group
  Ph. 03 9626 8314
  Email. Mark.Ciacic@dsto.defence.gov.au

- Michael Brincat
  Technical Officer
  Naval Architecture & Platform Systems Assessment
  Ph. 03 9626 7950
  Email. Michael.Brincat@dsto.defence.gov.au

B.2. Other Contacts

- Michael Assheton
  DATUM Electronics Australian Rep
  TC Process Equipment
  Ph. 02 9436 1428
  Email. massheton@tcprocess.com.au

Appendix C: Risk Assessment 2660

Australian Government
Department of Defence
Defence Science and
Technology Organisation

WorkingSAFER RISK ASSESSMENT REPORT

Initial Assessment Date	12/09/2013
Last Updated Date	19/09/2013
Next Review Date	Not set

Assessment Number	**2660** **Version** **1**
Assessment Title	**Torsionmeter Removal and Reinstallation Procedure**
Assessment Description	As part of its research program DSTO has fitted torsionmeter systems to two Armidale Class Patrol Boats, HMAS Maryborough and HMAS Glenelg. The torsionmeters are located on bobbin which is the coupling between the propulsion system gear box and propellor shaft. During major service of the propulsion system it becomes necessary to remove the bobbin hence the stator component of the torsionmeter must be first removed and the rotor component suitably protected. This Risk Assessment applies to the process of removing the stator, protecting the rotor and reinstalling the stator. It should be used in conjunctionwith RA 2661
Principal Risk Assessor	Vincent, Peter
Risk Assessment Contributors	Michael Brincat, Mark Ciacic
Approver Name	Norwood, Chris
Approver Comment	Risks notes and the assessment is approved
Approval Status	Awaiting Approval
Approval Date	13/09/2013 3:00:14 PM by user DSTO\norwood
Laboratory/Division	P&HS - J000010 MPD - J000104
State/Territory	VIC
Assessment Commencement Date	12/09/2013
Environment	Torsionmeter removal and reinstallation normally takes place on vessels that are docked or on the hard stand due to maintenance activity. The docked vessel has gangway access ramps or access stairs, the vessel is tied to the wharf and is staffed by Naval personnel
Equipment	The torsionmeter system is a commercial piece of equipment, that is supported by TC Process Equipment, it is installed between the gearbox and propeller shaft of the Armidale Class Patrol Boat
Personnel	Torsionmeter removal and reinstallation is technically challenging and requires a moderate amount of technical skill, it is reasonable to expect the technicians undertaking this activity have experience in working in heavy industries, such as found at ship yards. DSTO personnel undertaking this task have a large amount if previous experience in working at ship yards, all staff undertaing this activity are expected to have completed shipyard inductions.

HAZARDS ASSOCIATED WITH ASSESSMENT - 2660 , VERSION 1		RATINGS
1. HAZARD:	**ERGONOMICS /Other (non office)**	
Controls	Staff will be operating in a variety of ship areas when performing the trial, some of which may be cramped due to the presence of other personnel and equipment. If operating in these areas, staff shall take regular breaks (at least every half hour) to stand, stretch and move outside the area.	
Likelihood	If staff adhere to the prescibed controls and take regular rest and stretch breaks, the likelihood of an incident is reduced to unlikely	**Unlikely**
Consequences	If staff adhere to the prescibed controls and take regular rest and stretch breaks, the consequence of any ergonomic incident is considered to be minor, potentially requiring first aid.	**Minor**
Risk Rating	**Manage by routine procedures**	**Low**
2. HAZARD:	**HUMAN FACTORS /Manual handling**	
Controls	DSTO personnel are required to know and understand the requirements of the DSTO OH&S Manual – Procedure 3.04 on Manual Handling. All trials staff are to complete DSTO manual handling training if possible. Manual handling in accordance with this reference shall be practiced as a routine procedure. Staff shall minimise lifting of heavy equipment where possible and if lifting, practice safe lifting techniques including two person lifts, proper lifting techniques, and using trolleys to move equipment where possible.	
Likelihood	If staff adhere to the prescibed controls and minimise the amount of equipment lifted in a single action, the likelihood of an averse manual handling incident occuring is considered unlikely.	**Unlikely**
Consequences	Minimising the amount of equipment handled in a single transfer and the application of appropriate lifting techniques and mechanical aids reduces the possible consequence of any manual handling incident to minor, with any injury potentially requiring first aid.	**Minor**
Risk Rating	**Manage by routine procedures**	**Low**
3. HAZARD:	**HUMAN FACTORS /Travel**	
Controls	Staff are licenced and experienced (if driving is required), and are given appropriate time to travel to site. DSTO staff are to adhere to any reasonable request regarding safety whilst onboard the vessel.	
Likelihood	If staff adhere to the prescibed controls and obey reasonable safety instruction from DMS & HMAS Glenelg crew, the likelihood of a travel related incident occuring is considered unlikely.	**Unlikely**
Consequences	The consequence of a travel related incident whilst on board and under way is considered to be moderate, with medical treatment potentially required.	**Moderate**
Risk Rating	**Line management approval required - consider further risk reduction measures**	**Moderate**

4. HAZARD:	**PHYSICAL HAZARDS /Striking / grasping**	
Controls	The bolts used to attach the torsionmeter to the vessel can be very tight, in removing these there is the potential to slip and sustain a hand injure. It is intended that during the initial loosening of the bolt the technician should wear protective gloves.	
Likelihood	Without the prescribed contols the likelihood is high With this control the likelihood is rare.	**Rare**
Consequences	The consequence from striking is considered to be minor abrasion to the hands requiring first aid	**Minor**
Risk Rating	**Manage by routine procedures**	**Low**

5. HAZARD:	**PHYSICAL HAZARDS /Confined spaces**	
Controls	The torsionmeter is in an awkward location and requires the technicain to lean over and rest on the narrow edge of the disk brake, this can lead to chest bruising and soreness. It is recomended that heavy padding be placed ove the narrow edge of the disk brake during the activity, this has proved to be effective. Without this contol the likelyhood is high With this control the likelyhood is rare.	
Likelihood	Without the prescribed contols the likelihood is high With this control the likelihood is rare.	**Rare**
Consequences	With appropriate padding and regular breaks the consequence of working in an awkward position is considered minor strain on joints.	**Minor**
Risk Rating	**Manage by routine procedures**	**Low**

6. HAZARD:	**MECHANICAL /Power**	
Controls	The technician must work close to the propellor shaft during the maintenance activity, it is therefore imperative that the engine be locked out during this activity. This is a obvious hazard and Navy and Boat Yard always conduct exaustive inspections proir to engine startup. As an added measure the technician is required to inform the person in charge of the boat of his activities and check that the engine be locked out. This process is to be followed prior to commencing work in the morning and afternoon. Without this contol the likelyhood is rare With this control the likelyhood is rare	
Likelihood	Without this contol the likelihood is rare With this control the likelihood is rare	**Rare**
Consequences	The procedure results in the engine being locked out, this plus the exaustive inspections done prior to starting the motor makes the liklihood of starting the motor while the technician is working on the torsionmeter extremely remote. However if the motor started the consequence would be major injury.	**Major**
Risk Rating	**Senior management approval required - monitor closely**	**High**

7. HAZARD:	**ELECTRICAL /Energised electrical equipment**	
Controls	Staff should ensure that all leads to electrical equipment are free from damage and fit for purpose and protected from moisture. All leads should be layed out such that they minimise tripping hazards. All equipement should have in date electrical test tags.	
Likelihood	If staff adhere to prescribed controls the likelihood of an incident is reduced to rare	**Rare**
Consequences	If staff adhere to prescribed controls, the likihood of an electrical related incident is reduced however RCD protection does not and cannot eliminate the risk fully.	**Catastrophic**
Risk Rating	**Senior management approval required - monitor closely**	**High**

The following hazards have a risk rating of moderate or higher

Additional controls will need to be considered and factored into the relevant risk assessment to be conducted in the lab, workshop, field, trial, etc before commencement of work

HIGHER RISK HAZARDS FOR ASSESSMENT - 2660 , VERSION 1	RESULTANT RISK RATING
1.HUMAN FACTORS/Travel	**Moderate**
2.MECHANICAL/Power	**High**
3.ELECTRICAL/Energised electrical equipment	**High**

Appendix D: Risk Assessment 2661

Australian Government
Department of Defence
Defence Science and
Technology Organisation

WorkingSAFER RISK ASSESSMENT REPORT

Initial Assessment Date	27/07/2012
Last Updated Date	17/01/2013
Next Review Date	Not set

Assessment Number	**2661** **Version** **1**
Assessment Title	**Maintenance of DSTO system on docked RAN platforms**
Assessment Description	DSTO has a sensor systems installed on HMAS Glenelg and HMAS Maryborough, the systems requires maintenance which is carried out by DSTO staff while the vessel is either docked or dry-docked, this document assesses the risk associated with this work.
Principal Risk Assessor	Vincent, Peter
Risk Assessment Contributors	Alan Wilson
Approver Name	Norwood, Chris
Approver Comment	High risk for travel is noted.
Approval Status	Approved
Approval Date	13/12/2012 5:14:11 PM by user DSTO\norwood
Laboratory/Division	P&HS - J000010 MPD - J000104
State/Territory	N/A
Assessment Commencement Date	27/07/2012
Environment	HMAS Cairns, HMAS Coonawarra and Norship Ship Yard are locations that are used for Patrol Boat maintenance. Work is to take place on vessels that are docked or on the hard stand due to maintenance activity. The docked vessel has gangway access ramps or access stairs, the vessel is tied to the wharf and is staffed by Naval personnel.
Equipment	Equipment of the docked vessel to be maintained or repaired or installed are the sensors and associated infrastructure of the DSTO monitoring system.
Personnel	DSTO personnel undertaking task have a large amount if previous experience in trials at HMAS Coonawarra)a navel shipyard). Staff also have completed inductions required by DMS.

HAZARDS ASSOCIATED WITH ASSESSMENT - 2661 , VERSION 1		RATINGS
1. HAZARD:	**HUMAN FACTORS /Manual handling**	
Controls	Those involved in manual handling operations i.e. movement of equipment, carrying of tools etc will use manual aids where appropriate and will seek assistance when necessary. Any equipment used will be broken down into manageable sized items.	
Likelihood		**Unlikely**
Consequences		**Minor**
Risk Rating	**Manage by routine procedures**	**Low**
2. HAZARD:	**HUMAN FACTORS /Thermal extremes**	
Controls	Staff are provided with appropriate weather protection clothing and sun screening agents. Fresh drinking water is available for personnel. Exposure time to the elements will be kept to a minimum commensurate with the task being undertaken. Onshore facilities with heating and cooling are available to allow staff to recuperate if required. Help is readily available. In the case of extreme conditions the OIC can postpone activities until conditions improve.	
Likelihood		**Unlikely**
Consequences		**Minor**
Risk Rating	**Manage by routine procedures**	**Low**
3. HAZARD:	**HUMAN FACTORS /Travel**	
Controls	For motor vehicle travel staff are licensed and experienced, and are given appropriate time to travel to site, staff are to take rest breaks. Hire vehicles are assessed for safe operation prior to on road use and preference is given to vehicles with dual airbags and curtain airbags. For aircraft travel reputable airlines, with a long record of safe flight are used. Travel is undertaken outside of the defence environment and all civilian safety measures are undertaken during travel, while it is recognised that the risk rating is moderate this in the broad sense is accepted as reasonable in our society.	
Likelihood		**Rare**
Consequences		**Major**
Risk Rating	**Senior management approval required - monitor closely**	**High**

4. HAZARD:	**PHYSICAL HAZARDS /Slip / trip / fall**	
Controls	1. Even though the vessels have hand rails, care is to be taken getting on and off the vessel. 2. Extra care is required when moving from the wharf to the vessel, staff are aware that heavy and awkward items are to be passed from the wharf to the vessel and not carried across. 3. Being a vessel and susceptible to having a wet deck and sides, staff are to take care when moving around. 4. Moving from the wharf to the vessel personnel are to exercise care to ensure the have a secure footing at all times. 5. Appropriate footwear shall be worn to mitigate against slip hazards associated with working on wet surfaces. 6. Only the minimum amount of equipment, commensurate with the task at hand, will be place on board. 7. The deck shall be kept as free as possible from potential trip hazards.	
Likelihood		**Unlikely**
Consequences		**Minor**
Risk Rating	**Manage by routine procedures**	**Low**

5. HAZARD:	**PHYSICAL HAZARDS /Striking / grasping**	
Controls	The vessel is not at sea hence lurching of the vessel is unlikely to occur, some movement may occur due to movement on the mooring. Familiarisation with the vessel and the use of handholds wherever possible when walking enables better balance.	
Likelihood		**Unlikely**
Consequences		**Minor**
Risk Rating	**Manage by routine procedures**	**Low**

6. HAZARD:	**MECHANICAL /Noise**	
Controls	Engine noise is low and can be mitigated by the use of hearing protection if required. The time working on the boats with the engine running is kept to a minimum	
Likelihood		**Rare**
Consequences		**Minor**
Risk Rating	**Manage by routine procedures**	**Low**

7. HAZARD:	**RADIATION /Ultraviolet (include outdoor)**	
Controls	Sun burn hazards will be mitigated against by the use of full length clothing, sun smart hats and sun screen as required. These items are provided as personal issue or are available onsite.	
Likelihood		**Unlikely**
Consequences		**Minor**
Risk Rating	**Manage by routine procedures**	**Low**

8. HAZARD:	**WATER /On jetty / harbour**	
Controls	Administrative - Staff are made aware through training and experience of the hazards of steps, ropes, bollards etc that surround the wharf area. Staff are also aware of the need to not leave unsecured items on the wharf during the cyclone season.	
Likelihood		**Rare**
Consequences		**Minor**
Risk Rating	**Manage by routine procedures**	**Low**

The following hazards have a risk rating of moderate or higher

Additional controls will need to be considered and factored into the relevant risk assessment to be conducted in the lab, workshop, field, trial, etc before commencement of work

HIGHER RISK HAZARDS FOR ASSESSMENT - 2661 , VERSION 1	RESULTANT RISK RATING
1.HUMAN FACTORS/Travel	**High**

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION
DOCUMENT CONTROL DATA

1. DLM/CAVEAT (OF DOCUMENT)

2. TITLE

Armidale Class Patrol Boat□Torsionmeter Removal & Reinstallation Procedure

3. SECURITY CLASSIFICATION (FOR UNCLASSIFIED REPORTS THAT ARE LIMITED RELEASE USE (L) NEXT TO DOCUMENT CLASSIFICATION)

Document	(U)
Title	(U)
Abstract	(U)

4. AUTHOR(S)

Michael Brincat, Peter Vincent and Mark Ciacic

5. CORPORATE AUTHOR

DSTO Defence Science and Technology Organisation
506 Lorimer St
Fishermans Bend Victoria 3207 Australia

6a. DSTO NUMBER	6b. AR NUMBER	6c. TYPE OF REPORT	7. DOCUMENT DATE
DSTO-TN-1238	AR-015-792	Technical Note	October 2013

8. FILE NUMBER	9. TASK NUMBER	10. TASK SPONSOR	11. NO. OF PAGES	12. NO. OF REFERENCES
-	NAV07/359	HNE	17	5

13. DSTO Publications Repository

http://dspace.dsto.defence.gov.au/dspace/

14. RELEASE AUTHORITY

Chief, Maritime Division

15. SECONDARY RELEASE STATEMENT OF THIS DOCUMENT

Approved for public release

OVERSEAS ENQUIRIES OUTSIDE STATED LIMITATIONS SHOULD BE REFERRED THROUGH DOCUMENT EXCHANGE, PO BOX 1500, EDINBURGH, SA 5111

16. DELIBERATE ANNOUNCEMENT

No Limitations

17. CITATION IN OTHER DOCUMENTS Yes

18. DSTO RESEARCH LIBRARY THESAURUS

Torsionmeter, ACPB, shaftpower, reinstallation procedure

19. ABSTRACT

As part of its research program DSTO has fitted torsionmeter systems to two Armidale Class Patrol Boats, HMAS Maryborough and HMAS Glenelg. These systems consist of shaft mounted torsionmeters, an engine room mounted controller and a bridge mounted remote display. The torsionmeters are located on the bobbins which are the couplings between the propulsion system gear boxes and propellor shafts. The torsionmeters measure the torque and speed of rotation of the bobbin and consist of a rotating component (rotor) and a hull mounted surounding component (stator). During major service of the propulsion system it becomes necessary to remove the bobbin hence the stator component of the torsionmeter must be first removed and the rotor component suitably protected. This technical note describes the process of removing the stator, protecting the rotor and reinstalling the stator.